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ABSTRACT

The FORCAST readability index was developed and cross validated on technical job reading materials and job candidates. Several structural properties of passages were related to passage readability defined as the lowest measured reading grade level at which half the readers met a standard cloze criterion on the passage. The simple, single variable FORCAST Index correlates .9 with the Flesch and Dale-Chall Indices, has a cross-validity of .8 with the cloze criterion, and yields an average absolute error about half that of the two standard general readability indices studied. (Author)

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DEVELOPMENT OF A SIMPLE READABILITY INDEX FOR JOB READING MATERIAL

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PROBLEM

For some time we have been engaged in a program of research to determine the literacy skill requirements of Army jobs. One of our approaches has been to investigate the readability of printed materials used in the training for and performance of these jobs.

Readability indices (operations for determining the reading grade level required to read and understand a passage) are widely available. Typically, these readability indices have been developed on and for general reading material, such as newspapers and magazines, and for the non-technical reading material used in the elementary and secondary school systems. Moreover they have generally been normed or calibrated on the K-12 school population.

This led us to question the suitability of general readability indices *for our purposes* on 2 grounds:

1. The characteristically distinct style, format, and heavy use of technical nomenclature in job technical manuals;

2. The adult, employed, predominantly male, status of our readership.

An additional problem arises because some of the general readability indices require grammatical or linguistic competence on the part of the user, or the use of special word lists, tables, or equipment which are not likely to be routinely and generally available in many cases.

PROCEDURE

For the above reasons we undertook to develop a readability index which would be: (1) developed on essential job reading material; (2) normed for the young *adult* male population, and (3) simple and readily applicable by clerical personnel without special training or equipment.

Our procedure to develop the FORCAST readability index consisted of:

1. *Determine jobs to be included:* We selected 7 jobs which were heavily populated and which covered a wide range of occupational areas.

2. *Determine essential job reading materials:* For each of these jobs we selected the prescribed body of reading materials used by men to prepare for the annual test which qualifies them as proficient in their job. From this body of material we selected 12 150-word passages to represent the jobs as evenly as possible and to provide a range of difficulty.

3. *Assess the 12 reading passages in terms of structural properties:* We selected 15 standard structural properties to evaluate for use in the readability formula, including number of sentences, independent clauses, words per sentence, number of one-syllable words, letters per sentence, and the like.

4. *Measure reader comprehension of the job reading passages:* To do this, we tested the ability of 200 men to read and understand each of the 12 passages using the cloze procedure, in which every n^{th} word is deleted and the subject is required to fill-in the missing word. This procedure is highly correlated with multiple-choice comprehension testing, yet has the advantage of being completely non-judgmental and reproducible.

5. *Scale passages in terms of the reading grade level (RGL) required to achieve a comprehension criterion level of 35% correct:* To scale a passage for RGL, we used a version of the general reading ability of the 200 men who read the passage, then we determined the lowest RGL at which 50% of the men scored 35% correct on the job reading cloze test for the passage (a cloze score of 35% is roughly equivalent to 70% correct on a multiple-choice test. This criterion level is a standard, though arbitrary, criterion.)

6. *Calculate the regression equation best predicting the scaled RGL of passages from the structural properties of the passages:* Examination of the intercorrelations of the 15 structural properties of passages, singly and in various combinations, with cloze scores indicated that one factor -- number of one-syllable words per 150-word passage -- was as effective as any factor, and was certainly the easiest to apply.

Based on the foregoing analyses, we calculated the correlations between one-syllable words and the RGL associated with the criterion cloze score performance. This correlation was +.87. Regression analysis produced the following preliminary readability formula for 150-word passages: RGL = 20.43 - (.11) (number of one-syllable words in a 150-word passage). In the interest of simplicity, and at a small cost in accuracy, 20.43 and .11 were reduced to 20 and .10, and .10 was changed to 1/10, producing the very simple readability formula dubbed FORCAST (FORd, CAylor, STicht). The FORCAST formula for a 150-word passage is:

$$\text{RGL} = 20 - \frac{\text{Number of 1-syllable words}}{10}$$

To use the FORCAST formula to predict the RGL of a *150-word passage* one:

1. Counts the number of one-syllable words in the 150-word passage,
2. Divides that number by 10, and
3. Subtracts that value from 20.

For example, the estimated RGL of readability of a 150-word passage containing 96 one-syllable wrods would be 20 - (96/10) = 20 - 9.6 = 10.4, or about the middle of the tenth grade. This corresponds to the prediction that, on the average, men reading at the grade 10.4 level would be expected to get 35% correct on a cloze test with every 5th word deleted for the passage under consideration.

RESULTS

Table 1 summarizes the data for the sample from which the FORCAST index was derived. For comparison purposes, the widely used Flesch and Dale-Chall general readability indices were also applied to the experimental passages. The intercorrelations (in the .90s) among these 3 indices indicate that they are all ordering the passages in highly similar fashion. Similarly the 3 indices seem about equally and highly related to the criterion of Scaled RGL. Since our basic regression equation was derived from these data, the mean of its estimates would necessarily equal the scaled RGL mean of 9.9. The effects of rounding off the 2 decimal place precision of this regression equation to the simplified FORCAST formula is shown in the mean FORCAST estimate of 10.6. For the Flesch and Dale-Chall indices, however, this constitutes an independent validation study. These two general purpose readability

indices both overestimate the mean criterion readability for these passages by more than 1-1/2 years and their standard deviations are higher than that of the criterion measure by a similar amount.

A cross-validation study was then conducted, using a new sample of passages and a new sample of Ss to generate the Scaled RGL for the new passages.

Table 2 summarizes the cross-validation data. Again, the 3 indices intercorrelate highly. The FORCAST validity coefficient has shrunk to .77, about that of the Flesch and both somewhat lower than the Dale-Chall. The mean readability estimates of the 3 indices are all about the same -- and they here underestimate the Scaled RGL by 1 year. The standard deviation of the FORCAST estimates closely approximates that of the criterion while those of the general purpose indices are almost twice as large.

Cross-validation of the FORCAST confirms its validity for its intended purpose of estimating the reading difficulty of job reading materials. It can be readily applied by clerical personnel without extensive training or special equipment. Moreover, through avoiding extreme values, it yields estimates realistically useful for matching the reading ability of job incumbents with the reading ability demanded by printed job materials.

LIMITATIONS

The FORCAST formula was developed for and on a defined body of reading material (Army technical job reading matter) and a defined population of readers (young male soldiers). Unlike most general-purpose readability formulas, it was not intended for use with elementary and secondary school materials, or with newspaper and magazines, and its applicability to these is not demonstrated.

One apparent limitation to the FORCAST index is its restricted range. In the unlikely limiting case that all words in a 150-word passage of job material should be monosyllabic, the readability of the passage would be indexed as fifth grade (5.0) and the index will go no lower. To date, no passages of such low readability have been encountered in Army job material and a diligent search was necessary to turn up a passage as low as the 6.0 scaled reading grade level passage used in the experimental list. At the other extreme, the fact that a maximum score on the general reading test used in this study was normed as RGL 12.9 set this as the upper limit that could be assigned to the readability of a passage in developing the FORCAST formula. FORCAST predictions above that point are based upon linear extrapolation. However, any reading measure appropriate to the wide range of soldiers' reading ability must similarly be based upon extrapolation at both extremes. Any passage characterized as the 12th grade readability is a difficult one, and there is little need in practical application for precision beyond the simple ordering of even more difficult passages.

FORCAST Index

$$RGL_{*} = 20 - \frac{\text{Number of 1-syllable words}}{10}$$

* for a 150-word passage.

Table 1

Development of the FORCAST Formula: Means and Intercorrelations of Four Indexes of Passage Difficulty

Index	Intercorrelation				Mean	SD
	1	2	3	4		
1. FORCAST	-	.92	.94	.87	(10.6)	(1.9)
2. Flesch	.92	-	.97	.92	11.8	4.4
3. Dale-Chall	.94	.97	-	.93	11.6	3.9
4. Scaled RGL	.87	.92	.93	-	9.9	2.5

Table 2

Cross-Validation of the FORCAST Formula: Means and Intercorrelations Among Four Indexes of Passage Difficulty

Index	Intercorrelation				Mean	SD
	1	2	3	4		
1. FORCAST	-	.98	.95	.77	9.4	2.0
2. Flesch	.98	-	.94	.78	9.4	4.2
3. Dale-Chall	.95	.94	-	.86	9.5	4.0
4. Scaled RGL	.77	.78	.86	-	10.4	2.2

Footnote

1. The research reported in this paper was performed at the Human Resources Research Organization, Division No. 3, Presidio of Monterey, California under contract with the Department of the Army; the contents of this paper do not necessarily reflect official opinions or policies of the Department of the Army.

   A full report of this research is contained in: Caylor, John S., Sticht, Thomas G., Fox, Lynn C., and Ford, J. Patrick - *Methodologies for Determining Reading Requirements of Military Occupational Specialties*, HumRRO Technical Report (in press).